Cross-Site Study of the Implementation of Information Technology Innovations in Health Sciences Centers

Joan Ash, M.L.S., M.S., M.B.A.
Biomedical Information Communication Center
Oregon Health Sciences University
Portland, Oregon 97201-3098

An interpretive oral history technique was used to identify factors most important in the implementation stage of information technology innovation diffusion. Electronic mail, end user literature searching, and aspects of the computer-based patient record were the innovations selected for study at academic health sciences centers. Transcripts of thirty-four interviews with key individuals were analyzed to determine six categories of factors. Word counts were then used to determine underlying emphases. Analysis of variance tested whether there were significant differences in uses of words by categories of individuals, by those at different institutions, and when different innovations were described. Results indicate that the innovations themselves correlate significantly with different word categories, where category of individual and institution do not. Words related to the computer based patient record characterize further critical factors in implementing that particular innovation.

INTRODUCTION

Information technology holds great promise for improving efficiency in health care settings. "The evident lack of diffusion of information management technologies in the health care sector has limited the tools available for effective decision making from the bedside all the way to the formulation of national health care policy" [1]. Evaluation of the impact of information technology during and after implementation is critical if we are to learn from past efforts. Evaluation must consider organizational as well as technical factors [2].] Oral history offers a mechanism for providing rich information about multiple aspects of the implementation process because oral historians can ask open ended questions and elicit candid and insightful responses.

Implementation is one stage outlined in classical Diffusion Of Innovations (DOI) theory. DOI theory, presented first by Rogers in 1962 [3], describes four elements of diffusion: the innovation itself, communication channels, time, and the social system. The time element includes the stages known as knowledge, persuasion, decision, implementation, and confirmation. While Rogers was primarily concerned with individuals and not organizations, ongoing research confirms similar stages in the organizational diffusion process [4]. Recent studies have fine tuned the implementation and confirmation stages for information technology to define both the breadth and depth of diffusion: how many people use it and how sophisticated they are in using available options. The social system includes two types of individuals who can influence the process: the opinion leader, who is a peer; and the change agent, who works for a change agency. The importance of opinion leaders has been demonstrated time and again in many of the over 3,000 publications on diffusion of innovations [5]. Innovation attributes outlined by Rogers include relative advantage (how much better it is than its predecessor), compatibility (is it consistent with existing values of potential users?), complexity, trialability (if it can be experimented with), and observability (visibility).

Current research in diffusion of information technology innovations has added a level of detail and insight missing in previous studies, but building on them. On the individual level, there is a focus on the psychological attributes that motivate behavior. The Technology Acceptance Model (TAM) described by Davis [6] suggests perceived usefulness and perceived ease of use as antecedents of attitudes towards adoption and intent to adopt computer technology. Dixon and Dixon expanded the model and tested it for end user literature searching among primary care physicians. They conclude there is a large knowledge gap between current and expected knowledge, and also mention that rewards or mandatory use of searching might increase perceptions of usefulness. Mandatoriness of usage, or use demanded by authorities, has been shown by other researchers to have a significant effect on computer enabled innovation diffusion [7].

Another contemporary theory receiving attention in the information technology literature is the need for a critical mass of users [8-9]. As applications become more integrated, use of broad based systems like electronic mail and the computer-based patient record depends on everyone taking part.

Most of the innovation diffusion studies done to date have relied on factor analysis or multiple regression to determine which factors are most important in certain stages of the innovation diffusion process. Criticisms of innovation studies have been that they are not comparable because each innovation has different attributes, the unit of analysis has not always been

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clear, environmental influences are different in each subject arena, studies are not longitudinal, measurement techniques are not always validated, terms are not defined, and consequences or outcomes have received little attention [10].

The present study was designed to address a number of these methodological problems and to make a new attempt at defining important factors. It uses pattern coding and word counts to identify success factors.

METHOD

The Innovations

Three information technology innovations were selected for study based on their attributes. All have advantages over the way things were done before (manually), and all are readily "trialable" and observable. They differ, however, in complexity, compatibility, and need for a critical mass of users. End user searching (defined here as computerized searching of bibliographic databases by the individuals who will use the information) is as easy or complex as the user wishes, is fairly compatible with the way work is done, and does not need a critical mass of users. Electronic mail (defined as a method of communicating by means of computer, where a sender types a message and sends it to another computer user) varies in its complexity, is also fairly compatible with the way work is done, and does need a critical mass of other users. Finally, the computer-based patient record (CPR-- a system of networked multiple workstations which provide access to patient data) also varies in its complexity, is less compatible than the other two innovations with the way work has always been done, and depends a great deal on a critical mass of users.

Oral History

The use of oral history techniques for evaluating information technology innovations was pioneered at Baylor College of Medicine by G. Anthony Gorry, Principal Investgator of the IAIMS (Integrated Advanced Information Management Systems) grant, and oral historians Lesley Brunet and Charles Morrissey (11). They used it to evaluate implementation of the Virtual Notebook System developed as part of the project, reporting that "oral history is an innovative and suitable technique for ascertaining how people can be productive workers in a biomedical research environment in which advanced information technology plays a vital role "[12]. Briefly, oral history is

> a research technique that centers on the use and preservation of tape-recorded interviews for obtaining first-person accounts of how modern society has been shaped by causative factors of historical significance. Because oral communication has expanded with modern technology (the telephone, the jet engine for face-to-face meetings, etc.), oral history has flourished since the mid-60's as a means of ensuring historical records in an era when key events and policy decisions might otherwise suffer from inadequate documentation incurred by decreasing reliance on traditional modes of written communication [13].

The Baylor group presents its results in interview excerpts grouped into patterns or major topics. Often, oral history tapes and transcripts are stored for posterity, sometimes with instructions that they are not to be touched for a certain number of years. To evaluate information technology, the reading and interpretation must be done immediately to have an impact, however.

Qualitative researchers have used a variety of techniques to summarize and illustrate the interpretations of lengthy text resulting from interviews. Even the succinct report from Baylor fills twenty-three packed pages using the pattern grouping technique. An alternative or additional technique is "counting," which can keep one "analytically honest, protecting against bias" [14].

The Study

A series of thirty-four oral history interviews was scheduled at three progressive academic health sciences centers with sophisticated information technology and information services systems. Two of them have received IAIMS funding from the National Library of Medicine, though one is in the planning stage and the other in the implementation stage.

The interview subjects were nominated by the chief medical librarian at each institution based on each subject's level of involvement in integrated information technology and services efforts. Interviewees included administrators, faculty, computer professionals, and library staff. The researcher used an interview form, so the interviews were semi-structured. Confidentiality agreements were signed and each hour long interview was taped. Transcripts were later typed from the tapes. Two individuals reviewed the entire two hundred pages of transcripts, noting patterns of major points.

The present study uses both pattern coding and word counts to analyze the interviews. For pattern coding, the transcripts were annotated whenever an important factor was mentioned by the interviewee. The factors were then listed and grouped. In the second step, two researchers scanned the transcripts, picking out important words used often. The list of 124 key words was grouped into nine topics: costs, etc. Many of the words were synonyms.

TABLE 1
RESULTS OF PATTERN CODING: EXAMPLES OF QUOTES

1. Voluntariness or Mandatoriness of Usage:
   Example a: for e mail, we need "a stick offered by the administration saying this is the only way I'm going to communicate with you."
   Example b: on the CPR, "it took a lot of backbone, and we said look folks, you're going to do this, because you just better become part of the solution 'cause that's the way it's going to be. We held our ground, and now it's used as a recruiting tool."
2. Complexity of the Tool:
   Example a: the ease of use "of the technology in the introduction to a naive environment matters a great deal. I would guess that even if the ideal whiz bang [system] were there now, we'd get some resistance in changing. It would be short lived, not nearly as strong, but if you're a doctor or nurse and you have a routine, anything that's going to disturb that has got to be viewed in a negative way at least initially."
3. Rewards:
   Example a: "everybody here is aware they won't get tenure based on teamwork [for informatics projects]. Once you get tenure, teamwork can help you get grants and getting grants is what's important then."
   Example b: "informatics work has been regarded almost as a hobby to do in their spare time rather than an appropriate scholarly effort to be recognized in terms of merit increases and promotion and tenure and bringing honor to the department."
   Example c: "I've seen both moral and dollar support, which is a very precious thing."
4. Planning:
   Example a: "the planning element is a critical part of any organizational picture, but plans need to become the basis for working and striving to become better or more efficient. If it's no more than a piece of paper on the shelf, it's better not to plan at all."
   Example b: "institutions would be out of their minds not to be involved in planning [for information technology]."
5. Support:
   Example a: "it takes commitment from the top, visionary commitment and not just operational and implementation. Ours is a hierarchical system in medicine and a hierarchical training system... Dr. X stood up and said this is my vision. And in the hierarchy we all accepted that this was his vision and that the implementation of this system, no matter how burdensome, was part of that vision."
6. Champions:
   Example a: "we need to have physician involvement heavily and have to get it so users of the system want it, so it will make their lives easier, not just make the organization more prestigious or profitable; they have to perceive it as a help to them."
   Example b: "thank God we have a number of physician champions now... have a number of physicians who are interested, some are true believer champions, almost anything you do to automate is really great by their likes, and some are not particularly interested in automation but want to smooth the process and are only interested in terms of the impact on their operations.. Both are useful. The first will tinker with us, the others keep us from being self absorbed and look at the problem more and the technology less."

Table 1 provides examples of the major points made by interviewees in response to a general question about success factors for implementing information technology innovations. The strongest comments were made about: 1) voluntariness/mandatoriness of usage, meaning that for innovations like the CPR it may be necessary to require usage, 2) ease of use of the system, 3) reward structures, and specifically promotion and tenure guidelines, 4) planning, 5) financial and moral support, and 6) the importance of champions, or respected colleagues who help spearhead the effort. The wording of the comments in Table 1 has only been altered if it identified the respondent or institution in any way.

Rather than simply providing a list of similar, though articulately presented, comments, word counts offer a quantitative method for analyzing transcripts. Significant words that appeared in the transcripts multiple times and synonyms of those words were listed and grouped into nine categories. The transcripts were scanned manually, since a trial run using word searching on the computer was difficult. The difficulty lay in having to read the context around each word to ascertain if the word "network," for example was being used in the personal, human, sense, or in a computer technology sense. It was counted in the first instance but not in the second. Table 2 presents an abbreviated list of words and categories.

The final step was to analyze the word lists. The coding scheme included information about institutional affiliation, category of employee, and which innovation was being discussed at the time. Institution 1 was an IAIMS funded institution in the planning stage, Institution 2 was receiving IAIMS implementation funding, and Institution 3 was not an IAIMS. Interviewees were divided into administrative, faculty, computer related, and library related staff. These designations are not clear cut, however, since some library staff interviewed were library systems personnel (coded as library because that is where they work), and some administrators are also faculty (counted as administrators here). The three innovations were mentioned in all cases, but each individual was allowed to steer the discussion toward a favorite. The conversation often moved into a general discussion of all three innovations or of innovation in general, so a "general" innovation category was added to the coding scheme. A typical notation on the coding sheet might indicate that the word "obscene" was used once by a faculty member at Institution 1 in the context of a discussion about the CPR.

After counting and coding, the categories were analyzed using one way analysis of variance (ANOVA). The three hypotheses were 1) that there was a significant difference in the categories of words used from institution to institution, 2) that there was a significant difference in the categories of words used by different types of personnel working in different areas, and 3) that there was a significant difference in the categories of words used in relation to each of the three innovations.

RESULTS

Tables 1 and 2 show the examples of pattern coding and word counting in abbreviated form. Table 3 shows the frequencies of the word counts gathered into categories. It shows how many times the words were used 1) in reference to each innovation, 2) by interviewees divided by institution, and 3) by profession of the interviewees. Three one-way analysis of variance (ANOVA) tests were run to see if there were significant differences in word use. Only one test showed a significant difference, with a p value of .00499: the categories of terms used in reference to electronic mail, end user searching, and the computer-based patient record. Neither institution nor category of interviewee made a significant difference in use of words.

TABLE 2
WORD EXAMPLES

Cost Words	Planning Words	Other
account	dreams	acceptance
afford	goal	anxiety
bill	major thrust	awkward
bucks	mission	barrier
buy	objective	benefits
charge	planning	burden
etc.	etc.	challenge
		clumsy
Champion Words	**Cooperation Words**	complex
catalyst	blending	confidentiality
champion	collaboration	experiment
enthusiastic supervisor	connections	fear
go to bat	cooperation	flexible
innovator	coordinate	hideous
key individual	facilitate	obscene
etc.	etc.	obstacles
		order entry
Mandatoriness Words	**Management Words**	pain
comes down	commitment	privacy
dictate	clout	reluctance
direction from the top	core competencies	sophistication
hardnosed	critical mass	unified
mandate	culture	
ram	decisions	
etc.	etc.	
Rewards Words	**Marketing Words**	
career	assistance	
promotion	help	
recognition	needs analysis	
rewards	promote	
tenure	questionnaire	
etc.	etc	

DISCUSSION

The results of pattern coding indicated there are six major factors to be considered when implementing information technology innovations: voluntariness or mandatoriness of usage, complexity of the tool, rewards, planning, support, and champions. Voluntariness, rewards, and support are all closely related. This emphasis indicates the importance of strong management by individuals who are not afraid to mandate change, but who also will offer incentives and encouragement. All three factors are related to leadership. Planning is another management related activity. The importance of champions and the complexity of the tool are classical DOI factors. The results of the word count analysis shown in Table 3 indicate that the innovations themselves are related to more variance in types of words used than either institution or category of personnel. The ANOVA run on theWords vs. Institution section of the table indicated no significant difference even at the p=.10 level. This is perhaps because the institutions are alike in their use of words related to innovation,

TABLE 3
ANOVA RESULTS

Words vs. Innovation

	Frequencies		
	E mail	Searching	CPR
Word Groups			
Cost	52	25	59
Champions	1	0	17
Mandatoriness	7	1	5
Rewards	2	0	4
Planning	5	2	58
Cooperation	21	2	36
Management	24	4	59
Marketing	22	31	79
Other	49	9	79

Result: Significant at p=.00498

Words vs. Institution

	Frequencies		
	Institution 1	Institution 2	Institution 3
Word Groups			
Cost	154	87	90
Champions	11	8	6
Mandatoriness	16	6	1
Rewards	7	8	5
Planning	73	28	57
Cooperation	58	22	49
Management	84	52	46
Marketing	128	61	75
Other	57	27	59

Result: Not Significant

Words vs. Professional Category

	Frequencies			
	Adminstrators	Faculty	Computer	Library
Word Groups				
Cost	69	70	104	88
Champions	5	5	10	5
Mandatoriness	6	2	9	6
Rewards	7	8	1	4
Planning	32	36	63	27
Cooperation	34	23	48	24
Management	47	53	48	34
Marketing	29	20	138	77
Other	19	63	52	9

Result: Not Significant

though all are in different stages of IAIMS development. All are technologically progressive, however, and individuals at each have clearly thought intensely about the issues under discussion. The ANOVA run on the Words vs. Professional Category also showed no significant difference at the p=.10 level. The individuals in the different professions seem to share a vocabulary and level of interest in the innovations. The ANOVA on the Words vs. Innovation part of the table did indicate a significant difference. A close look at the word count frequencies in the top section of Table 3 explains why types of words used in relation to each of the three innovations varies significantly. The "other" category included emotion laden words such as anxiety, barrier, hideous, etc., and these were used primarily in relation to the CPR. Also, the marketing terms received an inordinate amount of attention when speaking of the CPR. Although interviewees were asked questions about end user searching, they preferred talking about e mail and the CPR, as evidenced by the number of words in each column.

Further research plans involve inclusion of more institutions in the study, greater refinement of the analysis of the transcripts, and a large scale quantitative study.

The progression from a less integrated information technology innovation such as end user searching, for which there is less need for a critical mass of users, to more integrated, complex and critical mass-dependent innovations like electronic mail and the CPR, is important to recognize during the implementation process. Just because an institution has successfully implemented end user searching does not mean that the same implementation techniques will work for the CPR. The factors outlined in the pattern analysis are universally important. In implementing the CPR, the preponderance of terms in the transcripts connected with champions, planning, management, and marketing, as volunteered by key individuals at leading edge institutions, indicates that these factors are especially important when implementing this particular innovation.

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